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Models of Superstardom: An Application of the Lotka and Yule Distributions

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Introduction

One common measure of success for popular recording artists is the receipt of gold or platinum sales awards. With regard to singles—the focus of this study—a gold award signifies sales of 1 million copies, whereas a platinum award signifies sales of 2 million copies (Recording Industry Association of America). A simple ranking of artists by the number of gold and platinum singles awarded demonstrates that relatively few artists have a great many awards, and that many artists have a few awards (see Tables 1 and 2). This skewness in success is often viewed as evidence of the superstar phenomenon. The superstar phenomenon is proposed to occur in occupations where personal rewards are closely associated with market size, and where, according to Rosen, there is "a strong tendency for both market size and reward to be skewed toward the most talented people in the activity" (845). In the next section we examine theories relating to superstardom. We then introduce two laws of scattering (namely those laws proposed by Lotka and Yule) that may be used to explain differences in success among music performers. We then test these theories against data collected for gold and platinum singles for 1958–2001. The paper concludes with a discussion of our findings.

Literature review

Noted economist Sherwin Rosen defines the phenomenon of superstars as occurring when "relatively small numbers of people earn enormous amounts of money and dominate the activities in which they engage" (845). Rosen goes on to propose that "[i]n certain kinds of economic activity there is a concentration of output among a few individuals, marked skewness in the associated distributions of income and very large rewards at the top" (845). Furthermore, he proposes that both demand and supply conditions may lead to skewness in earnings in some occupations. On the demand side, consumers view lesser quality performers as a poor substitute for more talented performers. As the demand for quality performers increases more than proportionately, higher-quality performers can gain greater incomes than their less talented counterparts. Or, as Glenn MacDonald puts it, "the distribution of income is not a simple rescaling of the distribution of ability" (155). On the supply side, performers are viewed as gaining economies of scale, whereby the costs associated with serving an additional consumer are lower than those associated with serving existing consumers. These economies of scale place talented performers at an advantage relative to their rivals in being able to meet

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Table 1. Performers with six or more gold records for singles, 1958–2001.

No. of gold records	Artist
51	Presley, Elvis
24	Beatles, The
	Madonna
19	Jackson, Janet
18	Houston, Whitney
16	Carey, Mariah
	Temptations
15	Franklin, Aretha
	John, Elton
13	Jackson, Michael
12	Prince
	Summer, Donna
11	Bee Gees
10	Boyz II Men
	Carpenters
	Creedence Clearwater Revival
9	Kelly, R.
	Newton-John, Olivia
	TLC
8	Earth, Wind & Fire
	Green, Al
	Kool & the Gang
	McCartney, Paul & Wings
	Michael, George
7	Braxton, Toni
	Brown, Bobby
	L.L. Cool J
	Three Dog Night
6	Captain & Tennille
	Cher
	Collins, Phil
	Denver, John
	Dr. Hook
	En Vogue
	Hall & Oates
	Joel, Billy
	Jordan, Montell
	Monica
	Monkees, The
	New Kids On The Block
	Notorious B.I.G.
	Salt 'n' Pepa
	Spinners
	Springsteen, Bruce
	War
	White, Barry

Table 2. Performers with three or more platinum singles, 1958–2001.

No. of platinum singles	Artist
27	Presley, Elvis
8	Carey, Mariah
7	Boyz II Men
	Houston, Whitney
	Jackson, Michael
6	Beatles, The
	John, Elton
5	Creedence Clearwater Revival
	Fifth Dimension
	Kelly, R.
	Monica
	Temptations
4	Bee Gees
	Madonna
	Notorious B.I.G.
	TLC
3	Backstreet Boys
	Diamond, Neil
	Dion, Celine
	Heatwave
	Jackson, Janet
	Salt 'n' Pepa
	Streisand, Barbra
	Usher

market demand for their recordings more cost-effectively. Also, technology (e.g., the production of recordings on compact disc) permits performers' work to be reproduced endlessly (Adler), so that "the costs of catering to larger audiences do not rise in proportion to the size of the market" (Strobl and Tucker 118). Hence, the development of media technology has been pivotal in enabling superstardom. In this regard the development of multimedia technology and the growth in global music television (e.g., MTV, VH1, and Country Music Television) has led music labels to leverage economies of scale by focusing on a relatively small number of star performers who could cater to larger audiences at lower cost (Strobl and Tucker).

A key feature of Rosen's view of superstars is that skewness in earnings is a function of differences in talent. Glenn MacDonald expounds upon this view when he explains the process by which superstars get started. MacDonald's view of skewness in earnings is similar to an explanation provided by Adam Smith in the *Wealth of Nations*, wherein it is suggested that, "in a profession where twenty fail for one that succeeds, that one ought to gain all that should have been gained by the unsuccessful twenty" (107). Smith proposed that the possibility of high rewards attracts individuals to enter professions with potentially high rewards and that younger performers are more likely to enter the profession as these individuals are more willing to engage in risky endeavors. MacDonald adds to

Smith's notion of superstar earnings by incorporating the role of the critic into the superstar model:

> In steady-state equilibrium those older performers who have been recipients of good reviews early on stay in the industry, earn large incomes playing to big crowds and exert control over great quantities of other inputs. Their audience is not often dissatisfied and pays a high price for this assurance. The less fortunate performers leave the industry. Entry only occurs among the young, who earn low incomes playing to small crowds. Their audience is disappointed comparatively often, but spend relatively little to gain admission. Overall, there are few stars in the industry—the older, well-established performers—but as a group they serve a large fraction of the audience and obtain an even larger share of the returns. The distribution of rewards is always positively skewed. (MacDonald 166)

MacDonald's view is given credence when we consider that age–earnings profiles are steeper for artists than for other workers (see, generally, Filer). Filer suggests that, if younger artists are an imperfect substitute for older artists, then "the difficulty of producing additional older, experienced members of the profession will result in there being 'rents' available to those already in the occupation" (68). In short, older, recognized, experienced artists are protected from the competition of younger, inexperienced artists, who are viewed by consumers as imperfect and inferior substitutes. The protection from yonger competitors allows experienced artists to reap monopoly profits (i.e., economic rents).

In contrast to the MacDonald–Rosen view of superstardom, Adler proposes that the phenomenon of stars exists when consumption requires knowledge—i.e., that the mechanism of stardom serves to assist consumers in minimizing consumption capital (search costs), rather than because some performers are more talented than others.

According to Adler, before purchasing an artist's work, consumers become aware of performers' music through listening to the work, or through discussing the work with knowledgeable others. These learning processes involve some search costs, which may take the form of going to a music store to listen to music, or spending time with friends discussing music. One means by which these search costs can be minimized is by choosing to purchase works by the most popular artists. Hence, Adler proposes that:

> It is plausible to assume that the cost of searching for knowledgeable discussants is minimized if one chooses the most popular artists. Thus, if other artists are not cheaper by more than the savings in search costs, one is better off patronizing the star. Alternatively, if other artists are not sufficiently better, one is better off patronizing the star. (208–09)

There is some empirical support for Adler's notion that superstardom is not necessarily a function of talent. For example, Hamlen examined the influence of various variables, including voice quality, on record sales. While observing that consumers discern quality in performers, Hamlen found that the "degree of proportionality between record sales and quality is significantly less than unity" ("Superstardom" 732). Hamlen found that factors other than quality were more significant in determining record sales, the most prominent of which is career longevity.

Several empirical laws—so-called laws of scattering—have been developed to explain patterns in the frequency distributions of artistic output, as is proposed by the superstar phenomenon. The two explanations that have received the

most attention for explaining the success of musicians are the Lotka and Yule distributions.

Lotka's law

Alfred J. Lotka, an insurance company statistician, developed the first law of scattering in 1926 in order to explain relative productivity among scientists. Using data in two indexes (one for the chemistry literature, and the other for physics), he plotted, on a logarithmic scale, the frequency of persons having made 1, 2, 3… scholarly contributions against the number of contributions. Lotka found that in "each case the points [were] rather closely scattered about an essentially straight line having a slope of approximately two to one" (317).[1]

Lotka's law is a special case of scattering distributions derived by Mandelbrot, Simon, and Bookstein. Those distributions suggest a generalized Lotka distribution as:

$$y_n = y_1 \frac{1}{n^k}$$

where y_n is the number of authors with n publications, y_1 is the number of authors with one publication and k is a constant. If $k = 2$, Lotka's inverse square law holds.

Two previous studies have examined whether Lotka's law applies to the distribution of success in the recorded music industry. The first of these studies, by Cox, Felton, and Chung, examined the distribution of gold and platinum awards per artist between 1958 and 1989. Lotka's law did not match this frequency distribution for either all records, gold records, platinum records, albums only, or singles only. However, the generalized Lotka distribution was found to be an excellent fit for all these measures of artistic success.

Cook also examined the applicability of Lotka's law, but to measure the distribution of artists producing top 40 hits between 1955 and 1984. He found that this distribution did not conform to Lotka's law. However, Cook proposed that "the marginal deviation from statistical significance may have been due to data contamination in that *Billboard* charts use some data manipulation rather than strictly object sales or air play data" (277).

Yule distribution

Lotka's law and the generalized Lotka distribution have been validated numerous times (see Huber). Nonetheless, as Lotka himself recognized, the distribution is simply descriptive and throws little or no light on the underlying processes that generates it. Simon was one of the first to look for processes whereby information search behavior would lead to "bandwagon" or "snowballing" effects. These effects take place when the likelihood that a consumer purchases music by a given artist increases along with the number of other consumers who have already selected that artist. If a slight majority of consumers pick one artist as their choice, that artist would snowball into a star because, after each period, the majority selecting that artist would increase. "Bandwagon" and "snowballing" effects rest on two basic assumptions:

- Assumption I. The probability that an additional consumer purchases a recording is an increasing function of the number of previous consumers who have also purchased that recording.
- Assumption II. The probability that an additional consumer purchases a recording that was not chosen by any of the previous consumers is a constant and near zero.

Assumptions I and II reflect the learning process, proposed by Adler, whereby a consumer's appreciation of a particular artist's output increases as her knowledge of the artist increases. Therefore, an individual's consumption decision over time involves a learning process during which consumers accumulate what is termed "consumption capital." In the music market, the learning process involves both listening to music and discussing music with others. Obviously, there is more to gain from the learning process when more consumers concentrate on the same artists. In this way, consumers minimize their consumption costs. This results in a snowballing of demand for the output of particular artists.

The scattering process resulting from "snowballing" can be modeled by the Yule distribution:

$$f(n) = \Psi\beta(n, \rho+1)$$

where Ψ and ρ are constants and $\beta(n, \rho+1)$ is the beta function of n and $\rho+1$. Simon shows that if Assumption II, given above, holds, then $\rho \approx 1$ and the Yule distribution can be approximated by the following form:

$$f(n) = \frac{1}{n(n+1)}$$

where $f(n)$ equals the proportion of artists having n gold (platinum) records. When $n = 1, f(1) = 0.50$; $n = 2, f(2) = 0.167$; $n = 3, f(3) = 0.085$; etc. The skewness of the Yule distribution suggests that, while many artists may achieve some initial success (e.g., a gold or platinum record) only a few—whether through talent (*à la* MacDonald–Rosen), or luck (*à la* Adler)—will break out of the mass and "snowball" to stardom. In the context of the Yule distribution, 50 percent of all those achieving gold or platinum record status will achieve only one gold or platinum recording, but 10 percent of all artists will grab hold of the attention of enough consumers eventually to earn ten or more gold or platinum recordings.

Chung and Cox examined the (combined) distribution of gold singles and albums awarded between 1958 and 1989. They found that the Yule distribution conforms closely to the distribution of gold records per artist, explaining around 94 percent of the empirical distribution of gold records among performers. In a more recent study, Strobl and Tucker examined whether album chart listings in the UK between 1980 and 1993 conformed to the Yule distribution. Strobl and Tucker observed that the distribution of chart-listed albums per artist and the distribution of chart-listed weeks per artist were "substantially skewed to the right, implying that a few artists produce a substantial number of chart-successful albums and that a few albums will remain in the charts for a long time period" (121). These authors found that the number of chart-listed albums per artists did conform to the Yule distribution; however, the number of chart-listed weeks per artist did not conform to this distribution. Strobl and Tucker conclude that the "underlying probability mechanism … is consistent with the snowballing effect of consumer demand" (130).

Method

Data were obtained from the Recording Industry Association of America's (RIAA) Gold and Platinum database (available at RIAA.org). The musical unit of interest is the single. The time period of interest is 1958 (when the RIAA first established gold record awards) to 2001. During this time, a total of 1,003 artists received gold singles awards and of these 229 gained platinum single awards. For these artists, we also collected the following data: (1) musical grouping: whether the performing entity was a solo artist, duo, or group; (2) gender: male, female, or mixed (for duos or groups); and (3) ethnicity: white, black, Hispanic/Latino, or mixed.

The musical grouping data were collected from RIAA.org and the gender and ethnicity data were obtained from AllMusic.com, a comprehensive online database. These data were collected in order to examine whether there was any consumer preference (or bias) toward (against) male vs. female performers, black vs. white performers, or musical groupings (solo artists vs. duos vs. groups).

Table 3 shows the frequency distribution of gold and platinum single recordings for the period 1958–2001. Among 1,003 performers earning gold record singles, 682 performers (68.0 percent) have one gold record, 135 have two gold records (13.5 percent), 79 have three gold records (7.9 percent), 32 have four gold records (3.2 percent), and only 75 have more than five gold records. In total, these performers produced 1,942 gold singles, an average of 1.94 awards per performer. Of the 229 performers earning platinum singles, 178 performers (77.7 percent) have one platinum record, 27 performers (11.8 percent) have two platinum records, eight performers (3.5 percent) have three platinum records, four performers have four platinum records, and twelve performers (5.2 percent) have five or more platinum records. Finally, 28 artists (representing 2.6 percent of all those earning a gold single) have slightly fewer than 20 percent of all gold singles. In a similar vein, five artists (representing 2.2 percent of all those earning a platinum single) have a little more than 15 percent of all platinum singles. These findings demonstrate the high degree of output concentration that exists amongst the top few "stars."

The results in Table 3 also reveal strong disparities by gender and race, particularly the interaction of gender and race. For gold singles, 343 white male artists earned 689 gold records in contrast to 89 white female artists with 191 gold records. For platinum singles, 55 white male artists earned 107 platinum in contrast to 23 white female artists with 39 platinum records. Similarly, 256 black male artists earned 485 gold singles with 92 black female artists having 236 gold singles; 77 black male artists earned 114 platinum singles with 30 black female artists having 52 platinum singles. Overall, male artists outnumber female artists by a factor of 3.4 to 1 (671/195) for gold singles and 1.7 to 1 (149/87) for platinum singles.

Empirical tests of Lotka's law and the Yule distribution

Table 3c provides the theoretical distributions indicated by Lotka's law and the Yule distribution. Goodness-of-fit tests were performed against these theoretical distributions by comparing the number of artists having n gold (platinum) against the expected number from the theoretical distribution.[2] Values of the test statistic are shown in the last two columns of Table 3a, b. The critical chi-square value for ten intervals at the 0.01 level of significance is 23.7.[3] Gold or platinum singles

Table 3. Frequency distribution of artists by number of (a) gold and (b) platinum singles recordings for the period 1958–2001; and (c) theoretical distributions indicated by Lotka's law and the Yule distribution.

(a)

Recording type	Artists	Records	Gold singles: frequency distribution (%)										Chi-square values	
			1	2	3	4	5	6	7	8	9	>9	Lotka	Yule
All gold singles	1003	1942	68.0	13.5	7.9	3.2	2.9	1.8	0.4	0.5	0.3	1.6	60.8*	173.4*
All males	671	1286	68.4	12.4	8.8	3.1	2.7	1.9	0.4	0.7	0.1	1.3	48.8*	123.8*
All females	195	450	62.1	15.4	8.7	3.1	4.1	2.1	0.5	0.0	1.0	3.1	9.9	21.6
Both males and females	110	179	68.2	20.0	2.7	4.5	2.7	0.9	0.0	0.0	0.0	0.9	14.3	27.1*
All whites	486	968	67.5	13.4	8.6	3.5	2.5	2.1	0.2	0.4	0.2	1.6	32.2*	84.1*
All black	388	787	64.2	15.5	8.2	3.1	3.4	1.8	0.8	0.8	0.5	1.8	17.8	49.9*
White males	343	689	67.9	11.1	10.2	3.5	2.6	2.3	0.3	0.6	0.0	1.5	32.1*	66.7*
White females	89	191	62.9	18.0	7.9	3.4	3.4	1.1	0.0	0.0	1.1	2.2	5.6	12.3
Black males	256	485	60.8	15.2	6.8	3.8	2.4	1.7	1.2	0.9	0.8	6.4	15.9	41.5*
Black females	92	236	58.7	14.1	10.9	3.3	3.3	3.3	1.1	0.0	1.1	4.3	5.6	7.8
All solos	477	1002	68.3	11.7	7.8	3.4	2.9	2.1	0.6	0.6	0.4	2.1	26.5*	79.6*
Male-solos	324	640	71.0	10.2	7.4	2.8	3.1	2.5	0.6	0.9	0.3	1.2	29.1*	70.1*
Female solos	148	354	62.2	15.5	8.8	4.1	2.7	1.4	0.7	0.0	0.7	4.1	4.1	14.2
Groups	437	802	65.4	16.0	9.2	2.7	3.4	1.1	0.2	0.5	0.2	1.1	34.3*	74.6*

Table 3 (Continued)
(b)

Recording Type	Artists	Records	Platinum singles: frequency distribution (%)										Chi-square values	
			1	2	3	4	5	6	7	8	9	>9	Lotka	Yule
All platinum singles	229	365	77.7	11.8	3.5	1.7	2.2	0.9	1.3	0.4	0.0	0.4	34.9*	78.1*
All males	149	241	78.5	12.1	2.7	1.3	2.0	1.3	1.3	0.0	0.0	0.7	25.1*	54.1*
All females	87	95	71.9	12.3	7.0	3.5	1.8	0.0	1.8	1.8	0.0	0.0	7.3	14.7
Both males and females	23	29	87.0	8.7	0.0	0.0	4.3	0.0	0.0	0.0	0.0	0.0	8.6	14.1
All whites	85	154	77.6	9.4	4.7	2.4	1.2	2.4	0.0	1.2	0.0	1.2	13.0	28.5*
All black	120	184	75.8	13.3	3.3	1.7	3.3	0.0	2.5	0.0	0.0	0.0	22.2*	41.3*
White males	55	107	78.2	9.1	3.6	1.8	1.8	3.6	0.0	0.0	0.0	1.8	10.2	20.0
White females	23	39	73.9	8.7	8.7	4.3	0.0	0.0	0.0	4.3	0.0	0.0	7.3	9.3
Black males	77	114	77.9	13.0	2.6	1.3	2.6	0.0	2.6	0.0	0.0	0.0	16.0	29.6*
Black females	30	52	66.7	16.7	6.7	3.3	3.3	0.0	3.3	0.0	0.0	0.0	4.4	6.8
All solos	107	193	74.8	13.1	3.7	1.9	1.9	0.9	1.9	0.9	0.0	0.9	13.0	30.5*
Male-solos	64	119	76.6	14.1	1.6	1.6	1.6	1.6	1.6	0.0	0.0	1.6	9.8	21.3
Female solos	43	74	72.1	11.6	7.0	2.3	2.3	0.0	2.3	2.3	0.0	0.0	6.8	11.8
Groups	97	142	79.4	10.3	3.1	2.1	3.1	1.0	1.0	0.0	0.0	0.0	18.1	37.2*

(c)

	Theoretical distributions									
	1	2	3	4	5	6	7	8	9	>9
Lotka's law	60.8	15.2	6.8	3.8	2.4	1.7	1.2	0.9	0.8	6.4
Yule's distribution	50.0	16.7	8.3	5.0	3.3	2.4	1.8	1.4	1.1	10.0

*Statistically significant difference at the 0.01 level of significance. With 10 intervals, the critical chi-square value for the rejection of the null hypothesis of no difference from Lotka's law or Yule's distribution at the 0.01 level of significance is 23.2. For various race-gender breakouts, intervals were combined to insure that each interval did not have an expected frequency fewer than 5. Critical chi-square values at the 0.01 level of significance consequently vary from one race-gender category to another.

across all artists do not conform to either Lotka's law or the Yule distribution. The actual distributions have larger percentages of artists at $n = 1$ and $n = 2$. In effect, the actual distributions imply less concentration (i.e., less skewness and less superstardom) of gold or platinum records for a few superstars than expected based on the theoretical distributions. Only 1.6 percent of all artists have ten or more gold singles and only 0.4 percent of all artists have 10 or more platinum singles. The expected percentages from the Lotka and Yule distributions are 6.4 percent and 10 percent, respectively.

Our results are consistent with Cox, Felton, and Chung's finding that Lotka's law did not predict commercial success for singles. However, our findings differ from those of Chung and Cox, who found that the Yule distribution provided an excellent description of the distribution of gold record awards during 1958–1989. This difference in research findings may be attributable to the fact that Chung and Cox combined both single and album awards for their analysis, whereas our study examines only singles. By merging single and album awards, Chung and Cox may have developed a more concentrated data set than would have been the case had they simply examined singles.[4] We believe that, although the single and albums markets are—at least to some extent—related, they should be viewed as separate markets and treated as such when examined for any approximation to laws of scattering.[5] It is also worthy of note that our data set contains an additional twelve years of data compared with the two studies we have just mentioned.

Our more detailed data breakouts indicate that the frequency distributions vary by race and gender. Lotka's law and the Yule distribution conform to the distributions of black artists, female artists, white female artists, black male artists, black female artists, and female soloists. The aggregated data (i.e., all gold or all platinum singles) capture the disagreement between the theoretical distributions and the actual distributions for white artists, male artists, white male artists, and male soloists. The processes generating superstardom appear to be at odds for those of different races and genders. Some explanations for this observation will be provided later.

Empirical tests of the generalized Lotka distribution

The generalized Lotka distribution may provide a good model even where the empirical distributions do not conform to Lotka's law. Moreover, the exponents determined from the generalized Lotka distribution directly measure differences in the concentration of output among a few superstar artists. The generalized Lotka distribution is given as:

$$y_n / y_1 = 1 / n^k$$

where y_n is the number of artists with n gold records, y_1 is the number of artists with one gold record, and k is a constant. Taking logarithms of each side of the above equation, we obtain:

$$\log(y_n / y_1) = -k \log(n)$$

Two regression equations were estimated for each of the gold singles distributions. The first set of regressions allows the intercept to be nonzero. A nonzero intercept violates the conditions necessary for the generalized Lotka. As found in Table 4, none of the intercepts was significantly different from zero. The second set

Table 4. Generalized Lotka's distribution for gold singles.

Recording type	$\log(a_n/a_1) = \beta_0 + \beta_1 \log(n) + \varepsilon_n$					$\log(a_n/a_1) = \beta_1 \log(n) + \varepsilon_n$			
	β_0	t value	β_1	t value	R^2	β_1	t value	R^2	Rank
All gold singles	0.098	0.704	–2.432	–11.96	0.953	–2.303	–27.18	0.989	
All males	0.115	0.612	–2.477	–9.03	0.921	–2.325	–20.57	0.981	11
All females	0.026	0.167	–2.040	–8.42	0.922	–2.004	–19.79	0.982	3
Both males & females	0.010	0.054	–2.254	–6.43	0.912	–2.228	–14.76	0.978	9
All whites	0.163	0.772	–2.616	–8.50	0.912	–2.401	–18.60	0.977	12
All black	0.057	0.689	–2.178	–17.91	0.979	–2.102	–41.57	0.995	5
White males	0.065	0.315	–2.329	–7.31	0.899	–2.239	–16.93	0.976	10
White females	0.003	0.026	–1.969	–11.74	0.965	–1.967	–26.93	0.992	2
Black males	0.023	0.203	–2.166	–13.29	0.962	–2.136	–32.47	0.992	6
Black females	–0.002	–0.017	–1.840	–11.22	0.954	–1.842	–26.95	0.990	1
All solos	0.028	–0.262	–2.237	–14.21	0.966	–2.220	–34.54	0.993	8
Male solos	–0.013	–0.091	–2.201	–10.14	0.936	–2.219	–25.38	0.988	7
Female solos	0.067	0.778	–2.174	–16.54	0.974	–2.083	–36.23	0.995	4
Groups	0.184	0.964	–2.627	–9.42	0.927	–2.384	–19.95	0.980	12

Lower ranked values of β_1 imply more concentration (i.e., more skewness) in the distribution.

of regressions estimates *k* after suppressing the intercept. The generalized Lotka provides an excellent fit to the theoretical data. The adjusted R^2 values are near 1.0 in every instance.

The absolute value of the coefficient, *k*, determines the degree of skewness in the distribution. Lower absolute values of *k* indicate higher proportions of artists with multiple gold records.[6] When the values of *k* are ranked from the lowest (most concentrated) to the highest (least concentrated), black females [1], white females [2], females [3], female solo artists [4], and blacks [5] are the five most concentrated categories. Categories of artists with the lowest values of *k* are the same groups with the smallest overall number of gold records. If a black or female artist has achieved gold record status, however, that black or female artist will have a greater chance of having multiple gold recordings than a white or a male.

Discussion

A major weakness of analyzing the correspondence between empirical and theoretical distributions of success is the absence of the underlying processes from which such distributions evolve. Distributions such as the Yule and Lotka have been applied to a wide range of seemingly unrelated phenomena, leading Chung and Cox to conclude that "it is hardly imaginable that there exists any commonality among word storage in human minds, blood cells on a microscope, and the fatal attraction of Sgt. Pepper's Lonely Hearts Club Band" (774). However, as Simon argues, "if these phenomena have any property in common it can only be the similarity in the underlying probability mechanisms" (425).

Several attempts have been made to develop a mathematical model that produces Lotka's law (see Huber for a discussion of these efforts). Many of these modeling efforts—largely dealing with scholarly publications—aim to explain the concept of cumulative advantage, i.e., that success breeds success. Huber reports four major findings: (1) individuals tend to produce at a constant rate over their careers; (2) individuals' outputs fluctuate over time randomly about their mean rate and generally follow a Poisson process; (3) The distribution of productivity (e.g., publications per year) across a sample follows the exponential distribution, not the normal distribution; and (4) the distribution of career duration across a sample also follows the exponential distribution, not the normal distribution. Equally important—and consistent with Hamlen's findings in "Superstardom in Popular Music"—these modeling efforts reveal that career duration and success are highly correlated. Cumulative advantage simply reduces to the well-known psychological observation that talented people tend to endure and less-talented people tend to move to other fields where they might have a better chance of success (see Miller). In effect, the observed distributions (e.g., Lotka or Yule) are the "result of continuous distributions of talent and tenacity" (Huber 209).

The findings that female and black artists have much lower Lotka exponents might suggest, in the context of the model described by Huber, that these groups face unique barriers to entry into the recording business. For example, Filer observes that

> black artists face less of an earnings disadvantage than black workers in general. When coupled with the observation that the proportion of artists who are black is less than that of the population, this suggests that restrictions on job opportunities for blacks in the arts … have resulted in only the most talented and determined blacks entering the field. (70)

It is often true that such barriers exist to individuals entering a profession. Typically, only the most talented and tenacious individuals overcome such obstacles (e.g., a Jackie Robinson or a Marian Anderson). Less talented individuals, who might have had some initial success if such barriers did not exist, are discouraged early in their careers. This might explain why the distributions of male and female artists (and white and black artists) display such different degrees of concentration. Moreover, if the existence of barriers leads to initial success of only the most talented artists and such individuals have the greatest tenacity and longest careers, it follows that artists successfully overcoming such obstacles will have lower Lotka exponents and more skewed distributions than would otherwise be the case.

The type of model described by Huber is clearly a useful starting point in understanding factors (e.g., racial or gender discrimination) accounting for the differences in distributions of gold singles across artist by race and gender. Nonetheless, Huber's model does not transfer directly to recording artists as reputation and consumer information most likely play a smaller role in (his example of) scholarly publications than in selling records. Many scholarly publications are double blind-refereed, and journals that have experimented with single- vs. double-blind refereeing have not found significant differences in which articles are accepted or rejected for those at top-ranked institutions (Blank).[7] Promotion of output also plays a different role. Known scholars clearly promote their students and colleagues, undoubtedly influencing their publication successes. Arguably, record labels that spend millions of dollars promoting recording artists have more influence. Moreover, a semi-blind process of selecting successful contributors to scholarly publications limits prejudice based on race and/or gender.[8] Finally, the nature of demand preferences for the works of recording artists and academic authors most likely diverge. Journal editors and journal referees provide preferences for academic journals. Consumers and, more importantly, the money they have to spend, define preferences for recording artists. For example, gender differences in the distributions of gold singles for male and female artists, rather than implying discrimination, may simply reflect Alan Wells's proposition that

> Women may hold female artists as positive role models. But particularly for the younger audience, it's the male star they idolize.... Young males do not seem to follow the same pattern. They may listen to a few female artists but they do not idolize them.... Teenage males are more likely to be drawn to the macho image of the hard rocker.... The market for female artists is therefore limited by both male and female sectors of the audience. (74)

Nevertheless, Huber's model is useful in pointing out that productivity and career longevity are important determinants of cumulative advantage. In the context of music, those artists producing more singles during their career are likely to have more gold or platinum awards. Likewise, artists with longer careers are likely to have accumulated more awards. It may be the case that black and/or female artists—having faced greater barriers to their success than their counterparts—are determined to make the most of their success when it does occur and are therefore more productive, with longer careers. This phenomenon could be a function of perseverance; having to overcome more obstacles to achieve some degree of initial success may act to develop artists who are inherently more motivated to succeed further once they have reached that point.

Yet another reason for the more skewed distribution of black artists may be found in the identification that fans of these artists feel toward such superstars. Alberoni proposes that "stars are proclaimed as such by the collectivity. It is not they themselves who impose themselves on the latter by a power acquired independently of the collectivity" (93). Hence, stars are "made," in part, by their fans. Or, as Lewis observes, "[stardom] is a quality which is bestowed upon certain people by a specific audience which intentionally wishes to bestow such a quality" (74). The question of interest to us is: why would the audience of black artists bestow more success on those performers who have already reached an initial level of success (i.e., upon performers who already have one gold single)? First, it is fair to observe that black artists have a disproportionately high representation in certain genres of music, most notably in soul, R&B, and rap music. In turn, these genres of music appear to be preferred more by music buyers who are black rather than by those who are white. For example, in a study of adolescents, Hakanen and Wells found that blacks liked R&B/soul music significantly more than whites, but liked rock music significantly less than other racial groups. Perhaps, black fans—by virtue of their own struggles—identify closely with the struggles that black artists have faced to become successful and, therefore, are more supportive and loyal as fans, i.e., more likely to buy music that is released by successful black artists. Alternatively, black artists having gained some initial degree of success may be more likely than white artists to gain further success because they are better performers. Put another way, having overcome greater obstacles—and having greater talent—than most of their white counterparts, black performers who reach an initial level of success (a gold single) may be more likely than their counterparts to achieve further success.

The preceding discussion leads to a number of questions that are worthy of further research: Do black and/or female musicians face unique barriers to success? Are these barriers such that when these performers achieve an initial level of success they are more productive and/or have longer careers? Are fans of female and/or black artists more loyal to star musicians? Do search costs for black and/or female artists who have experienced some initial success differ from those of their counterparts? Does this lead to more rapid snowballing effects? Answering questions such as these will give us a greater understanding of the reasons underlying different distributions of success for these artists.

Notes

1. The general formula for the Lotka relationship is given as $n^k y = c$ where y is the relative frequency of authors with n publications, and k and c are constants. Based on a value of k of approximately –2, Lotka's law is given as $y_n = c/n^2$ so that $y_1 = c/1^2$, $y_2 = c/2^2$, $y_3 = c/3^2$, ... For the case where $k = 2$, the value of constant, c, is found as

$$\sum_{n=1}^{\infty} y_n = c\sum_{n=1}^{\infty} \frac{1}{n^2} = c\frac{\pi^2}{6}$$

By definition, $\sum_{n=1}^{\infty} y_n = 1$, thereby determining the value of the constant, c, as

$$c = \frac{6}{\pi^2}$$

and

$$y_n = \frac{6}{\pi^2}\frac{1}{n^2}$$

Since, $\frac{6}{\pi^2} \approx 0.60$, the equation representing Lotka's law can be written as $y_n = \frac{0.60}{\pi^2}$.

2. To do this, we used the formula

$$\chi^2_{\text{test statistic}} = \sum (Actual_n - Expected_n)^2 / Expected_n$$

3. The Chi-square tests require that the expected number of observations in each category should be at least five. Intervals were combined for some of the race and gender breakouts to satisfy this requirement. Critical Chi-square values are adjusted to take this into account.
4. Some evidence of this in found in Cox, Felton, and Chung, which uses the same data set, but also examines platinum awards. Although these researchers again combine single and album awards in virtually all of their analyses, they do provide an estimate of the generalized Lotka equation and a chi-square test for singles (their Table III, p. 337). Their results for the generalized Lotka equation are very similar to our findings. Nonetheless, Cox, Felton, and Chung ignore these findings in favor of results that combine both single and album awards and that show much greater concentration.
5. Crain and Tollison refer to the single and albums markets as "multi-market stages", wherein the singles markets serves to filter out "lesser quality individuals" (2). This assertion is also given empirical support by Hamlen ("Variety").
6. For example, when $k = 1.5$, about one in three artists will have five or more gold singles. By contrast, when $k = 2.5$, about one in twenty artists will have five or more gold singles. Alternatively, when $k = 1.5$, the odds in favor of achieving a second gold single are about three to two. By contrast, in a distribution where $k = 2.5$, the odds in favor of achieving a second gold single are about one to three.
7. "Single-blind" refers to the situation where the author does not know who the reviewer is, but the referee does know who the author is. "Double-blind" means that both the author and the reviewer are not informed of one another's identities.
8. Blank concludes that "women do slightly better under a double-blind system, both in terms of acceptance rates and referee ratings, [but] these effects are relatively small and statistically insignificant" (1063).

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